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EVALUATION OF SEVEN FUNGICIDES TO CONTROL CANKER DISEASES
OF BAREROOT DOUGLAS-FIR IN PACIFIC NORTHWEST NURSERIES

REPORT NO. R6-86-14

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ABSTRACT

The fungicides Benlate, Captan, Chipco 26019, Daconil 2787, Difolatan, Mertect, and Zyban were applied periodically at five nurseries in Oregon and Washington for control of Douglas-fir canker diseases. Hypocotyl rot, resulting from ground-line infections by *F. oxysporum*, was reduced by Benlate at two nurseries; the other fungicides were less effective. Upper stem infections resulting in top mortality were caused primarily by *Phoma* spp. and *Fusarium* spp. and occurred in October and early November. In two nurseries which experienced relatively high levels of upper stem canker, all fungicides significantly reduced cankering. Lower stem cankers, seen in spring and summer of the second year, were not controlled by fungicides if cankers were at groundline; good control was achieved with Daconil and Difolatan when cankers were higher on the stem and not covered with a soil collar. Cankers caused by *Botrytis* were prevalent in the summer and fall of the second year at one nursery; all fungicides gave effective control, although Daconil and Difolatan were superior.

INTRODUCTION

Stem canker diseases of Douglas-fir, formerly called "top blight", have caused considerable losses in Pacific Northwest forest nurseries. Several genera of fungi are associated with stem cankers. Currently, four different diseases have been distinguished on the basis of unique symptoms, locus of infection, time of infection, and associated fungi (Hamm, personal communication; Hamm et al. 1985; James and Hamm 1985).

1. Fusarium Hypocotyl Rot. This disease is initiated in the summer and early fall of the first year. Infection of the stem at or near the ground- line is caused primarily by *Fusarium oxysporum*.

2. Upper Stem Canker. Upper stem cankering commences in the fall of the first year. Infections by *Phoma eupyrena* and *Fusarium roseum* occur on the upper portion of the main stem and result in cankers and mortality of the stem above the canker. Cankers are often associated with bark fissures caused by rapid seedling growth.

3. Lower Stem Canker. Lower stem cankering is initiated between late fall of the first and spring of the second year. Symptoms and mortality are often not seen until after bud break. Cankers on the lower stem are caused by *F. roseum* and *P. eupyrena*, and usually are associated with soil collars, soil abrasions, and dead needles.

4. Phomopsis and Botrytis Cankers. These cankers are formed in the spring, summer, and fall of the second year on second-year growth. Infections by *Phomopsis* spp. and *Botrytis cinerea* on new growth result in cankers and mortality of the stem above the canker.

Prevention of Douglas-fir canker diseases with fungicide applications usually has been ineffective or, at best, has given sporadic control. No one fungicide or fungicide schedule seemed to be superior, although several fungicides have shown potential, based either on reported success in the field or on results of in vitro testing (Cooley, 1984; Kliejunas, 1982; Triebwasser, personal communication).

A 2-year field test of seven potentially effective fungicides at five forest nurseries in the Pacific Northwest was initiated in 1984. The goals of this test were twofold: (1) to determine if incidence of canker diseases could be reduced with periodic fungicide applications and (2) to determine which fungicides were most effective.

METHODS

Location

The five nurseries which were selected were Weyerhaeuser Aurora Forest Nursery in Aurora, Oregon; International Paper Kellogg Nursery in Kellogg, Oregon; Weyerhaeuser Mima Forest Nursery in Olympia, Washington; Industrial Forest Nursery in Toledo, Washington; and Viewcrest Nursery in Battleground, Washington.

Experimental Design

A randomized block design was used at all five nurseries. Five or six (depending on nursery) fungicide plots and one check plot were arranged randomly within each of three or four replications. Plot size varied between 100 sq. ft. and 7200 sq. ft., depending on nursery (Appendix A).

Fungicides, Rates, Frequency of Treatment

Fungicides were applied at the following rates in 50 to 100 gallons of water per acre:

Benlate 50 WP (Dupont): 1 lb ai (Toledo, Viewcrest)
3 lb ai (Aurora, Kellogg)
4 lb ai (Mima)
Captan 50 WP (Stauffer): 4 lb ai
Chipco 26019 (Rhone-Poulenc): 3 lb ai
Daconil 2787 (Diamond-Shamrock): 4 lb ai
Difolatan (Chevron): 2 lb ai
Mertect (Merck): 1.4 lb ai
Zyban (Mallinckrodt): 1.5 lb ai

1984: Seedlings were treated every 2 weeks, beginning 2 weeks after full emergence through the end of September. Treatments continued at monthly intervals through fall and winter at Aurora, Mima, and Toledo. Treatment schedules varied between nurseries, because of weather and nursery schedules. Fungicide application dates are shown in the following table.

Nursery	1984:						Date of Application								
Aurora	----	----	----	7/18	8/3	8/17	9/2	9/14	9/27	----	10/16	11/5	----	----	----
Kellogg	----	6/28	7/10	7/24	----	----	----	----	9/19	----	-----	----	----	----	----
Mima	----	---	----	7/24	8/7	8/21	9/10	9/18	9/24	----	10/16	----	11/20	----	----
Toledo	----	----	----	7/31	8/14	8/28	----	9/17	9/28	10/15	10/24	11/5	11/19	12/11	12/27
Viewcrest	6/8	6/22	7/5	7/19	8/21	8/30	----	9/17	----	----	----	----	----	----	----

1985: Nurseries which expected or had experienced significant amounts of lower stem canker in previous years applied the fungicides at monthly intervals during the winter and early spring prior to bud break. Those nurseries not expecting lower stem canker to occur stopped fungicide treatments in the fall of 1984 and resumed spraying in the spring of 1985 at bud break. All nurseries applied fungicides at approximately 2-week intervals from bud break in April until bud set or later (late June to early November). Fungicide application dates are shown in the following table.

Nursery	1985:							Date	of	Application								
Aurora	1/4	----	----	4/11	4/253	5/12	5/24	6/7	6/21	7/7	----	----	----	----	----			
Kellogg	----	----	----	4/7	----	5/2	5/30	6/17	6/27	----	-----	----	8/9	8/23	9/13			
Mima	1/5	2/20	3/13	4/4	----	5/1	5/15	6/3	6/20	----	----	----	----	----	----			
Toledo	----	----	----	----	----	5/2	5/21	6/4	6/18	7/2	7/16	7/30	8/15	8/29	9/13			
Viewcrest	----	----	----	4/15	----	5/2	5/14	6/3	6/19	7/1	7/17	----	8/2	----	----	9/25	10/11	11/1

Not all fungicides were applied at each nursery. The following table shows the fungicides that were used at each nursery; seedling type and bed density (average of seedling counts in plots) also are listed.

Aurora	Kellogg	Mima	Toledo	Viewcrest
2-0	2-0	2-0	1-0	2-0
27/sq ft	36/sq ft	25/sq ft	53/sq ft	41/sq ft
Benlate	Benlate	Benlate	Benlate	Benlate
-	Captan	-	Captan	Captan
Chipco	Chipco	Chipco	Chipco	Chipco
Daconil	Daconil	Daconil	Daconil	Daconil
Difolatan	Difolatan	Difolatan	Difolatan	Difolatan
Mertect	-	Mertect	-	-
Zyban	-	Zyban	-	-

Evaluation of Treatments

The number of dead or diseased seedlings was counted at the end of each disease period: November 1984 (Fusarium hypocotyl rot, upper stem canker), May to June 1985 (lower stem canker), August 1985 (Botrytis and Phomopsis canker), and November 1985 (Botrytis canker, Toledo only). The number of living and diseased seedlings was counted in several sample plots within each treatment plot. Sample size was roughly correlated to plot size, with ten 1-square foot sample plots per treatment plot counted at Kellogg, 20 sample plots at Toledo and Viewcrest, and 40 sample plots at Aurora and Mima. The percentage of diseased seedlings over all sample plots was calculated for each treatment plot. If possible, direct isolations from diseased seedlings were made from each nursery to identify the fungi associated with observed damage.

RESULTS

Seven fungicides were evaluated for effectiveness against four canker diseases during 1984 and 1985. Not all diseases occurred at each nursery; in fact, some nurseries showed insignificant amounts of any disease over the 2 years of testing.

Fusarium Hypocotyl Rot

Figure 1 shows the percentage of seedlings which died during the summer and early fall from hypocotyl infections at each nursery. (Also see Fusarium Hypocotyl Rot, Table 1 in Appendix B). The amount of mortality ranged from about 14 percent in Block 11 at Mima to less than 0.2 percent at Aurora. Fungicide effects were seen only at those nurseries with relatively high amounts of damage (i.e., Mima and Toledo). At Toledo and in both blocks at Mima, percent mortality in Benlate plots was about one-half that found in check plots. Only Benlate and Difolatan were significantly1/ better than no treatment at Mima (Block 14 only). At Toledo, Benlate was significantly better than Difolatan, but neither was different than the check or other fungicides.

1/ All statistical comparisons in this report are considered significant if the probability of larger F is $\geq .05$. Comparison of treatment means was made using Duncan's New Multiple Range Test.

Isolations from groundline lesions on recently killed seedlings yielded mostly <u>F. oxysporum</u> with lesser amount of <u>F. roseum</u>. Roots of symptomatic seedlings were healthy.

Upper Stem Canker

Figure 2 shows the percentage of seedlings with upper stem infections occurring in the fall of the first year. (Also see Upper Stem Canker, Table 1 in Appendix B). Incidence of upper stem cankers ranged from 9 percent in the check at Toledo to 0 percent for some of the fungicide treatments at other nurseries. Only at Toledo and Viewcrest, where upper stem canker damage was greater than 1 percent in check plots, were all fungicides significantly better than the check. At Toledo, Benlate and Chipco were better than Captan and Daconil. At Viewcrest, no differences were seen between fungicides.

The amount of damage at Aurora, Kellogg, and Mima was very low (<0.5 percent). However, there were apparent differences between the check and most of the fungicide treatments. At Aurora, no disease was found in Benlate, Chipco, Daconil, and Difolatan treatments. At Kellogg, no disease was found in Benlate, Captan, and Daconil treatments. At Mima, no disease or low levels of disease were seen in Chipco, Daconil, and Difolatan treatments.

Direct isolations from symptomatic top-killed Douglas-fir yielded the following fungi. At Aurora, Mima, Toledo, and Viewcrest, the most frequently isolated fungus was <u>Phoma eupyrena</u>; <u>Fusarium roseum</u> and, infrequently, <u>F. oxysporum</u> were recovered as well. At Kellogg, nearly equal amounts of <u>P. eupyrena</u>, <u>P. pomorum</u>, <u>F. roseum</u>, and <u>F. oxysporum</u> were isolated.

Lower Stem Canker

The percentage of seedlings with lower stem cankers is shown in Figure 3. (Also see Lower Stem Canker, Table 2 in Appendix B). Disease levels were less than 5 percent at four of the five nurseries. At Mima, up to 14 percent of seedlings were diseased in some treatments. However, disease severity at Mima was related more to bed topography (more disease in low spots) than to fungicide effectiveness. At all nurseries, Daconil treatments resulted in the lowest or next to lowest amount of disease. And, except at Mima and Kellogg, check plots had the highest or next to highest levels of disease. One or more fungicides showed lower levels of disease than the check at Aurora, Toledo, and Viewcrest. At Kellogg, higher levels of mortality in Captan and Chipco treatments were because mortality from Phytophthora root rot was prevalent and was not differentiated from lower stem canker when plots were sampled.

Isolations from and incubation of symptomatic seedlings from Mima yielded <u>Phoma eupyrena</u> and <u>Fusarium roseum</u>[2/]. <u>Phoma</u> spp. and <u>Fusarium</u> spp. were recovered from symptomatic seedlings from Toledo[3/].

2/ Isolations made by Dr. W. Littke, Weyerhaeuser Company, Centralia, WA and P. B. Hamm, Dept. Botany and Plant Pathology, OSU, Corvallis, OR.

3/ Isolations made by S. Frankel, Peninsulab, Kingston, WA.

Phomopsis and Botrytis Canker

Figure 4 shows the percentage of seedlings with cankers on the second-year growth caused by *Phomopsis* spp. and *Botrytis* spp. (Also see *Phomopsis*/*Botrytis* canker, Table 2 in Appendix B). Low amounts of disease occurred at all nurseries. Highest levels were seen at Toledo with 1.6 percent of seedlings affected in check plots. Levels below .5 percent for all treatments, including checks, were seen at Aurora, Kellogg, Mima, and Viewcrest. At Toledo, all treatments were significantly better than no treatment. Daconil gave the best protection.

At Toledo, cankers caused primarily by *Botrytis* spp. continued to occur into the fall of the second year. An additional evaluation was made in November to quantify these later-occurring cankers. Fungicide treatments had been continued through the first of November. The check areas had the highest amount of disease (average of 2.9 percent); four of the five fungicide treatments resulted in significantly lower levels of disease than the check. As with the earlier evaluation, Daconil performed the best. (Also see Phomopsis/Botrytis canker, Toledo Late -, Table 2 in Appendix B).

Summary

The following table summarizes the results. The three or four most effective fungicides for each disease are listed with a comment on the relative effectiveness of each.

Disease	Effective Fungicides	Comments
Fusarium Hypocotyl Rot	Benlate	Variable effectiveness
	Daconil 2787	Variable effectiveness
	Chipco 26019(NR)1/	Variable effectiveness
Upper stem canker	Chipco 26019 (NR)	Best
	Daconil 2787	Good
	Difolatan (NR)	Good
	Benlate	Good
Lower stem canker	Daconil 2787	Best
	Difolatan (NR)	Good
	Benlate	Variable effectiveness
Botrytis canker	Daconil 2787	Best
	Difolatan (NR)	Best
	Benlate	Variable effectiveness

1/ NR = Not registered for forest nursery use.

DISCUSSION

Summer mortality of 1-0 seedlings, attributed to Fusarium oxysporum infection at the groundline, was widespread in nurseries throughout the Northwest in 1984 and 1985 and was seen in a northern California nursery in 1984 as well.

Although mortality caused by F. oxysporum has been observed before, it apparently has never before been quantified. Although some fungicides such as Benlate appeared to reduce the amount of disease, most had little effect. Earlier treatment and perhaps different formulations or modes of application (e.g., soil drenches or incorporation of granular formulations) might be more effective.

Differences in incidence of Fusarium hypocotyl rot were seen between Blocks 11 and 14 at Mima. These differences may be related to the cropping and cultural history of each block. Block 11, experiencing very little disease, has grown conifers for several years with fumigations between crops. Block 14 on the other hand, was used as seedbed for the first time in 1984; supported 1 year of transplants previously, and has been fumigated only once. Seed inoculum loads may have differed between blocks as well.

The amount of upper stem canker in the first year (1984) was quite low at most participating nurseries. However, two of the five nurseries did experience some degree of disease. At Toledo and Viewcrest, all fungicides significantly reduced top mortality. At the other nurseries, where damage was very low, fungicide effects were not apparent. Fungicide treatments for upper stem canker may need to be tailored to fit specific weather conditions and seedling development rates. For example, when seedlings are slow to harden off and set bud during wet late summers and falls, more frequent and extended applications will be needed.

Infection of the stem at or slightly above groundline (lower stem canker) occurred during the first winter or early spring of the second year. Foliar symptoms (chlorosis, wilting, mortality) resulting from lower stem cankers appeared after seedlings had broken bud. The incidence of lower stem canker was low at all nurseries except Mima, which experienced high amounts of damage in isolated spots. These spots of high damage were lower and wetter than adjacent areas, and consequently, suffered more soil splash and build-up on seedling stems. Algae growth occurred on soil in these wet areas. Soil collars which remained wet due to poor drainage and algae are likely to have created an ideal environment around the stem for infection by soil-borne canker fungi. Lower stem cankers at Mima resulted in death of the seedling because cankers were below the lowest living branches. At Toledo and Viewcrest, cankers were not all at groundline, and frequently, the seedling was not killed.

At Mima, the ineffectiveness of fungicides to prevent lower stem canker is not surpising due to the apparent inability of fungicides to penetrate soil collars (Littke, personal communication) and infrequent (monthly) fungicide applications during the likely period of infection (winter, early spring). Prevention of soil collars or soil splash may be a more effective means of controlling lower stem canker than fungicide treatments. Use of various mulches to prevent soil build-up has been minimally investigated and needs further field trials.

Cankers caused by Botrytis or Phomopsis on second-year growth were extremely rare at four of the five nurseries. At Toledo, damage from Botrytis was relatively high due, most likely, to abundant inoculum in the understory.

Botrytis was visibly present on needles and small branches beneath the canopy; high seedling density probably promoted good Botrytis growth. As with lower stem canker, some cankering occurred later than expected; cankers due to Botrytis were seen in October as well as in August. At Toledo, both lower stem cankers and Botrytis cankers were effectively controlled by one or more of the tested fungicides. This was probably due to the potential canker location being high on the stem where fungicides would be able to reach and protect it.

In general, fungicides were most effective against above-ground cankers not covered by soil. In nurseries where incidence of above-ground cankers was greater than 1.0 percent, almost any fungicide applied at approximately 2-week intervals resulted in a substantial reduction in disease.

Rates used in this evaluation were higher than label recommendations. Individual nurseries will need to try lower rates. Disease control may be just as or nearly as effective at lower rates, and obviously, reduced rates will reduce the expense of treating susceptible crops.

ECONOMIC CONSIDERATIONS

The number of seedlings with Fusarium hypocotyl rot and lower stem canker represent actual losses in the number of packable seedlings. With upper stem canker and Botrytis/Phomopsis canker, the number of affected seedlings do not necessarily represent an equal loss in number of packable seedlings; many of these diseased trees will make packing standards, particularly if cankers are fairly high on the stem, if replacement leader growth is good, and/or if multiple tops are acceptable. For cankers high on the stem, the cost of fungicide applications must be weighed against the actual increase in number of packable seedlings. If, with fungicides, the increase in disease-free seedlings is slight and many diseased seedlings are acceptable anyway, fungicide applications may not be economically reasonable. However, fungicide application costs tend to be small, so that costs are quickly recouped with almost any fungicide benefit.

An example is presented below where benefits of treatment outweigh the cost of treatment. Data is taken from fungicide plots at the Toledo IFA Nursery. The most prevalent diseases in these plots were upper stem canker and Botrytis canker.

Production Impacts

Fungicide treatments are expected to increase the number of packable trees. Based on data from fungicide trial plots, the various fungicides are projected to increase output as follows:

Fungicide	No. packable trees/400 sq. ft.	% Increase over check
Benlate	15,944	20.1
Chipco	15,506	17.07
Difolatan	15,231	16.49
Daconil	15,181	16.22
Captan	14,031	9.35
Check	12,719	-
	Average	15.85%

Rotating between fungicides results in an average increase of 15.85 percent in packable trees per unit area.

Without fungicide treatment, packable tree production is expected to be 1,024,000 trees per acre. This is based on:

32,000	square feet of bed per acre
x32	packable trees/sq. foot (= density of check plots)
1,024,000	trees/acre

With fungicide treatment, production is expected to increase by 15.85 percent or 153,600 trees per acre (1,024,000 x .1585 = 153,600).

Treatment Costs

Fungicide treatment requires expenditures for labor, equipment, and fungicide. The per acre cost of treatment is estimated to be $1784.55.

Labor and equipment costs are estimated at $10.00 and $1.25 per hour of application, respectively. It takes 50 minutes to apply fungicide to one acre. Therefore, at the hourly rates, labor and equipment costs are $9.50 per acre ($11.25/hour=$.19/min.; $.19 x 50 min. = $9.50).

Cost of each fungicide for one application over one acre are listed below; rates used in this example were double the label rates.

Fungicides	Rate	Cost/Lb.	Total
Benlate	2 lb./ac.	$13.25	$ 26.50
Captan	8 lb./ac.	2.03	16.24
Chipco	6 lb./ac.	18.52	111.12
Daconil	5 lb./ac.	25.70	128.50
Difolatan	5 lb/ac.	5.41	27.05
		Average	$ 61.88

Assuming the frequency of each fungicides' use is the same, fungicide cost will average $61.88 per application per acre. With an expectation of 25 applications over the 2 year treatment period (7/31/84 to 9/13/85), total fungicide costs will be $1547.05 per acre ($61.88 x 25 = $1547.05).

Total treatment costs will be the cost of fungicide, $1547.05, and the cost of labor and equipment, $237.50 ($9.50/acre x 25 = $237.50), which equals $1784.55.

Benefits

The advantages of fungicide treatment to a nursery can be viewed from two perspectives. First, there is an opportunity to increase tree production and profits on the area currently under cultivation (Option 1). Second, there is an opportunity to gain a cost saving by reducing the area under cultivation while maintaining production (Option 2).

Option 1. If there is no limit to the number of trees your nursery can sell or your clients can use, then you will wish to increase your production and, therefore, your profits.

With an investment of $1784.55 per acre for fungicide applications over a 2-year period, an additional $7,680 per acre can be realized if the price of trees is $50.00 per thousand ($50.00/M x 153.600 M/ac = $7,680/ac). This is a profit of $5,895.45 per acre.

Option 2. If there is a limit on the number of trees your nursery can sell or your clients can use, then you will wish to maintain production but on fewer acres.

With fungicide treatments, 15 percent less land could be sown (based on 15% increase in production). A savings of up to 15 percent could then be realized for a number of items (e.g., 15% decrease in amount of soil fumigated @$1000.00/ac x .15 = $150.00 savings/acre).

Activities and materials, which could be reduced with use of fewer acres, would need to be determined and then savings on these would need to be totaled to determine total savings.

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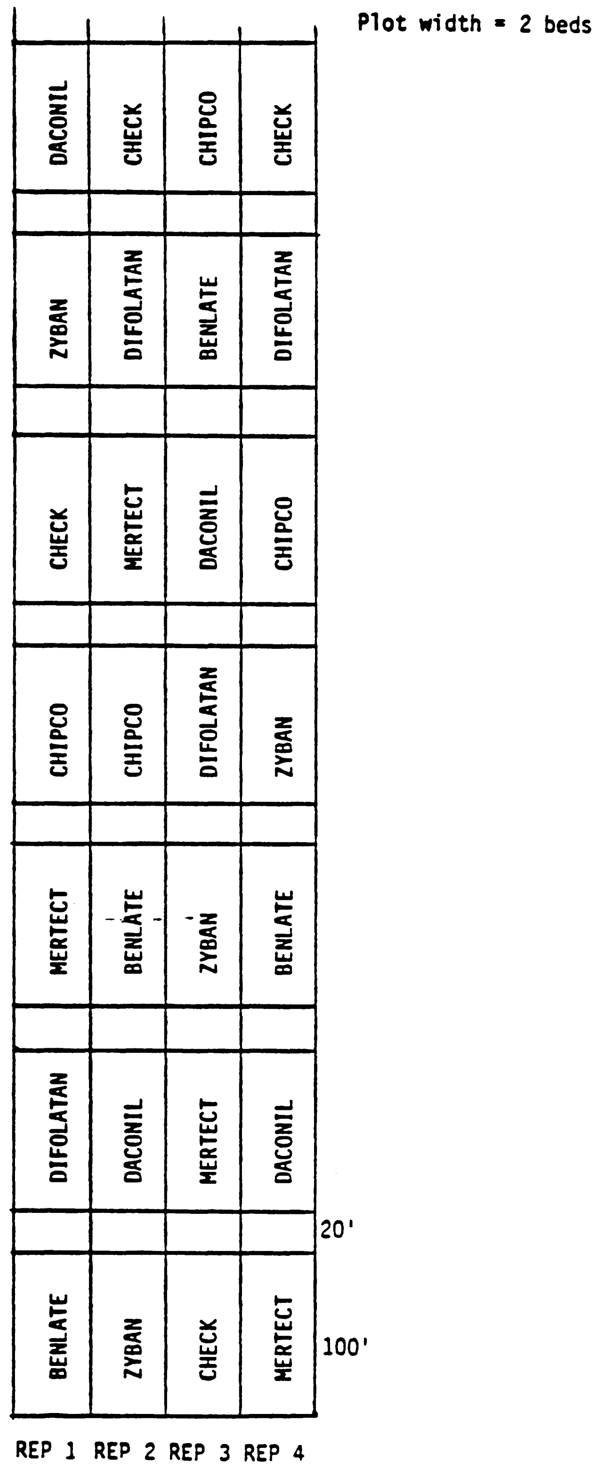
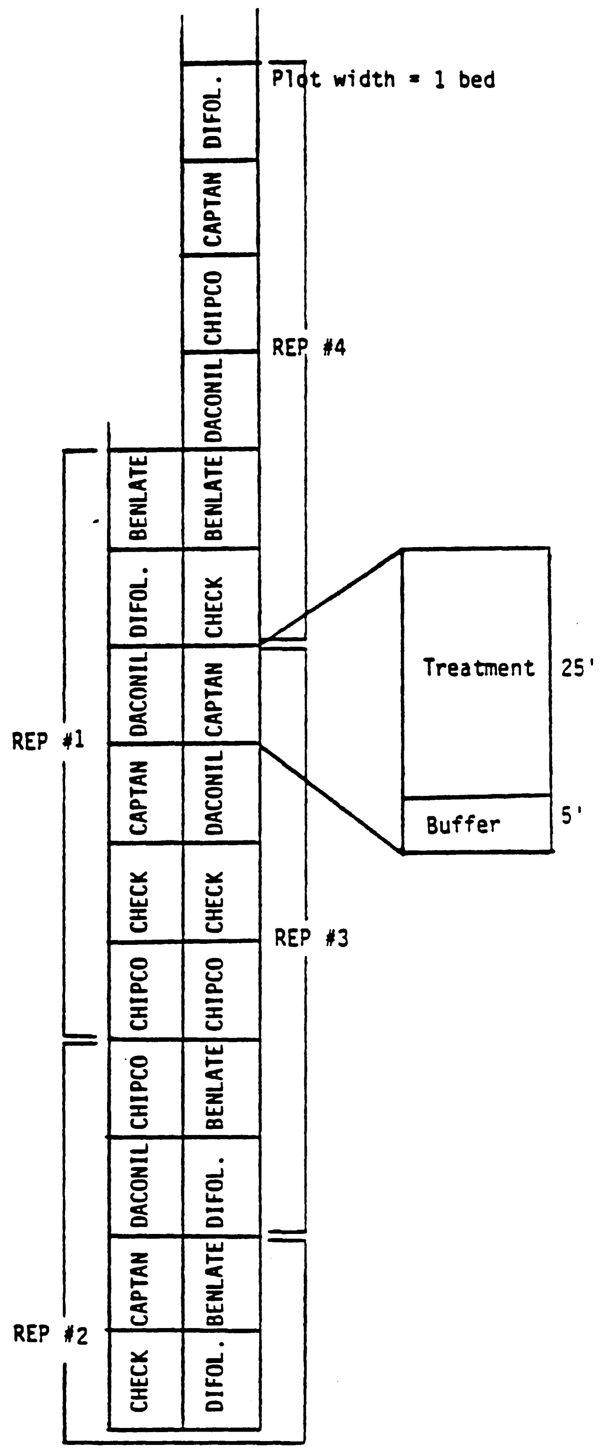
APPENDIX A

Plot Maps: Page

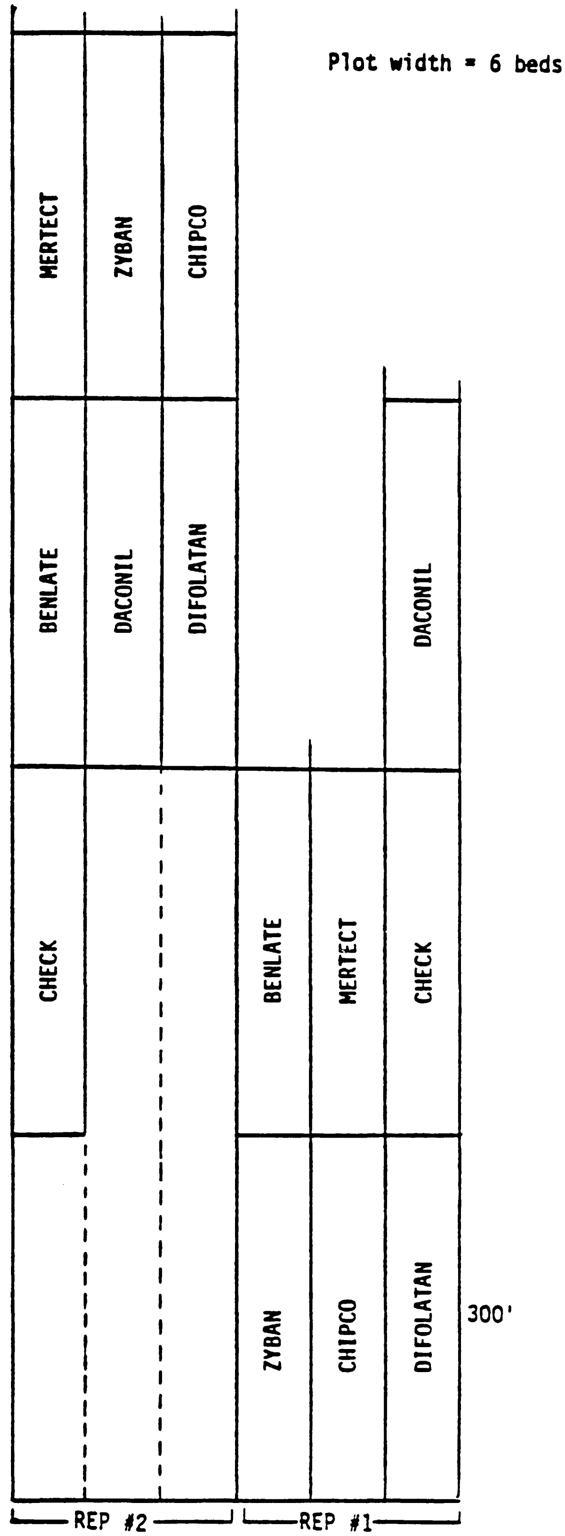
APPENDIX A. Figure 1. Plot Arrangement, Aurora Nursery.
Block 5, Beds 515 to 522. Not to Scale.



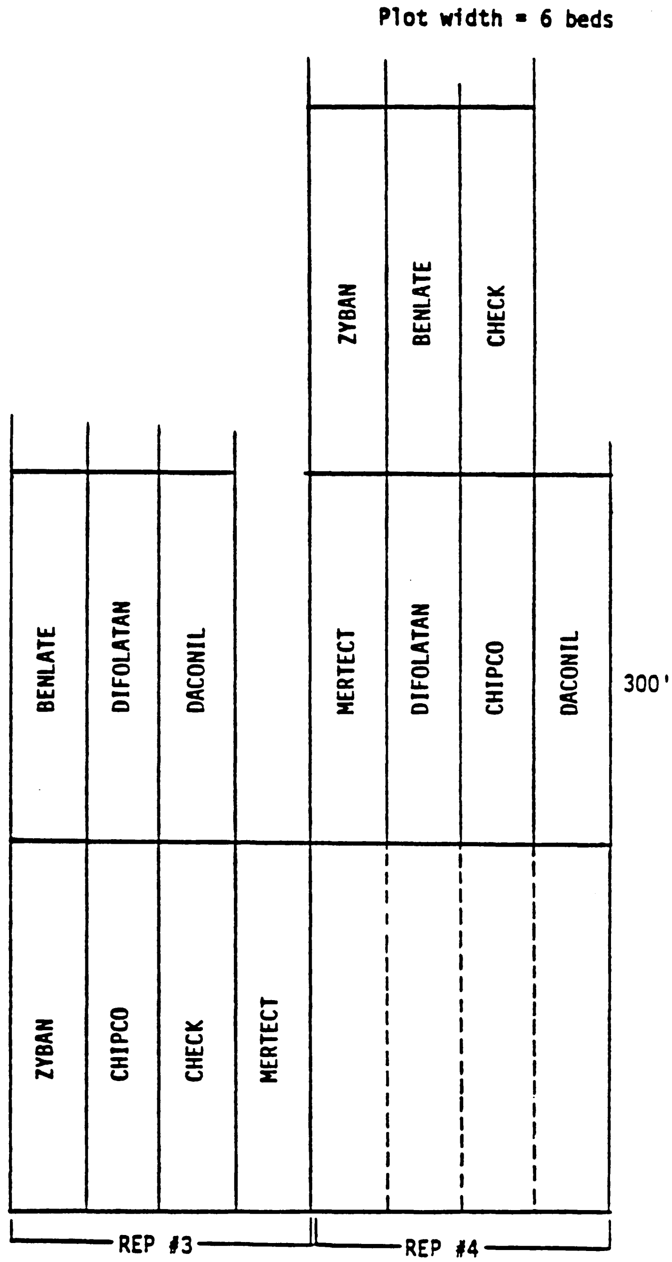
APPENDIX A. Figure 2. Plot Arrangement, Kellogg Nursery. Block 2, Beds 643 and 644. Not to Scale.



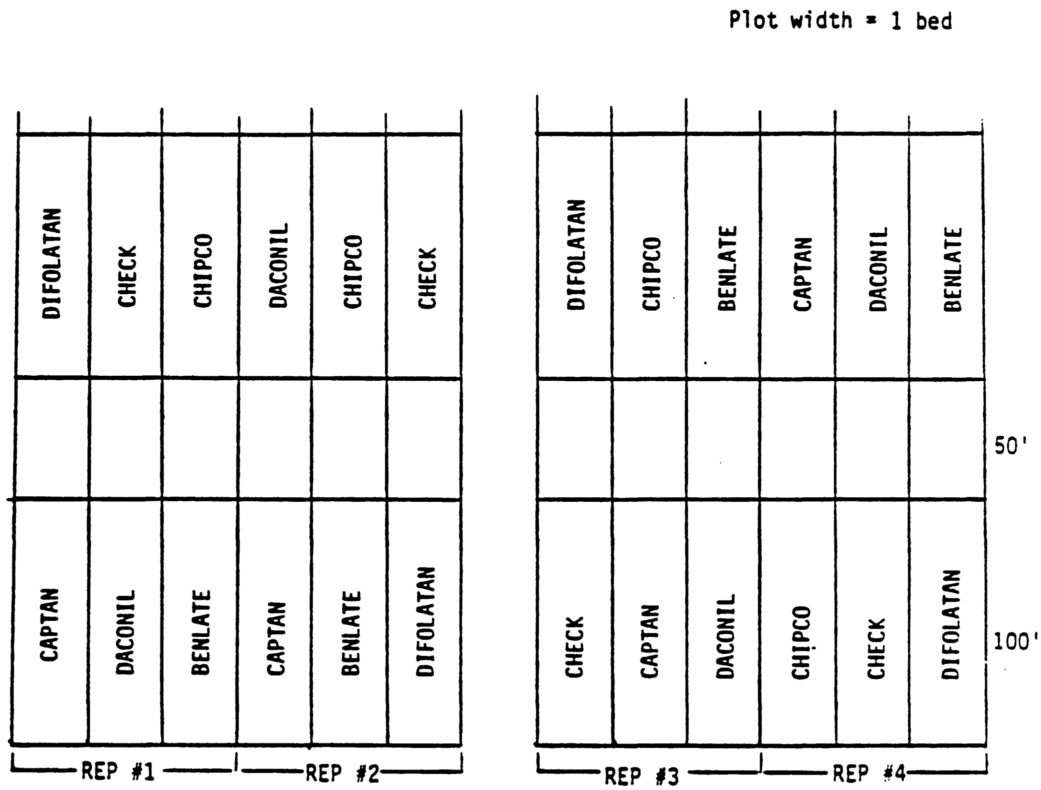
APPENDIX A. Figure 3. Plot Arrangement, Mima Nursery. Block 11, Beds 57 to 87. Not to Scale.



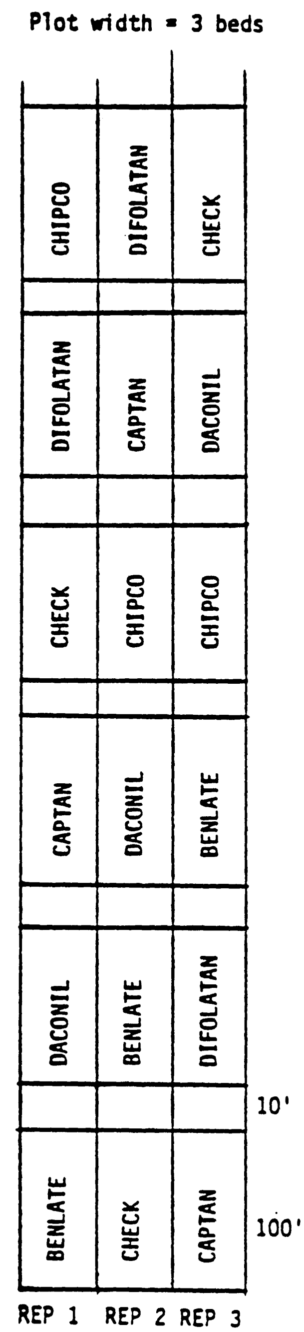
APPENDIX A. Figure 4. Plot Arrangement, Mima Nursery. Block 14, Beds 62 to 109. Not to Scale.



APPENDIX A. Figure 5. Plot Arrangement, Toledo Nursery.
Block 11, Beds 49 to 61. Not to Scale.



APPENDIX A. Figure 6. Plot Arrangement, Viewcrest Nursery. Not to Scale.



APPENDIX B

Table of Means: Page

APPENDIX B. Table 1. Table of Means: Percentage of seedlings with Fusarium hypocotyl rot and percentage of seedlings with upper stem cankers.

	FUSARIUM HYPOCOTYL ROT			UPPER STEM CANKER		
NURSERY	FUNGICIDE	MEAN*	SEM**	FUNGICIDE	MEAN*	SEM**
AURORA	Chipco	.24 a	.11	Zyban	.15	.06
	Zyban	.17 a	.02	Check	.07	.02
	Daconil	.13 a	.04	Mertect	.02	.02
	Benlate	.10 a	.07	Benlate	0	0
	Difolatan	.08 a	.08	Difolatan	0	0
	Check	.06 a	.03	Chipco	0	0
	Mertect	.05 a	.03	Daconil	0	0
KELLOGG	Benlate	1.89 a	.38	Chipco	.13	.07
	Difolatan	1.58 a	.41	Difolatan	.14	.14
	Chipco	1.51 a	.39	Check	.07	.07
	Check	1.27 a	.53	Captan	0	0
	Captan	1.11 a	.23	Benlate	0	0
	Daconil	1.04 a	.28	Daconil	0	0
MIMA-11	Chipco	13.97 a	3.47	Zyban	.34	.06
	Mertect	12.59 a	2.68	Benlate	.14	.04
	Check	12.11 a	3.50	Check	.24	.24
	Difolatan	10.67 a	.84	Daconil	.09	.09
	Zyban	10.50 a	3.98	Mertect	.09	.09
	Daconil	8.73 a	4.07	Difolatan	.04	.04
	Benlate	6.70 a	1.86	Chipco	0	0
MIMA-14	Check	7.40 a	4.01	Check	.52	.10
	Mertect	6.70 ab	3.30	Zyban	.21	.03
	Chipco	4.42 abc	2.58	Benlate	.20	.04
	Zyban	4.23 abc	2.31	Mertect	.20	.11
	Daconil	3.20 abc	.53	Chipco	.04	.04
	Difolatan	2.23 bc	.66	Difolatan	.04	.04
	Benlate	.86 c	.04	Daconil	0	0
TOLEDO	Difolatan	3.28 a	1.31	Check	9.05 a	.90
	Check	2.70 ab	.33	Captan	4.55 b	.73
	Captan	2.71 ab	.89	Daconil	4.08 b	1.25
	Daconil	2.51 ab	.77	Difolatan	2.95 bc	.85
	Chipco	1.57 ab	.32	Benlate	1.84 c	.51
	Benlate	1.38 b	.31	Chipco	1.37 c	.15
VIEWCREST	Captan	1.58 a	.38	Check	3.05 a	1.07
	Check	1.58 a	.74	Captan	.44 b	.26
	Difolatan	1.55 a	.42	Benlate	.34 b	.07
	Daconil	1.53 a	.96	Chipco	.29 b	.28
	Chipco	1.50 a	.85	Daconil	.26 b	.26
	Benlate	1.31 a	.37	Difolatan	.09 b	.04

*Means (within each nursery and within the same vertical column) followed by the same letter are not significantly different according to Duncan's New Multiple-Range Test, (p .05). Analysis of variance and Duncan's were performed on transformed (arcsin percentage) values for each set of data. However, analyses of variance were not appropriate where one or more treatment mean equaled zero since variances were therefore unequal.

**SEM = Standard Error of Mean.

APPENDIX B. Table 2. Table of Means: Percentage of seedlings with lower stem cankers and percentage of seedlings with Phomopsis or Botrytis cankers.

	LOWER STEM CANKER			PHOMOPSIS/BOTRYTIS CANKER		
NURSERY	FUNGICIDE	MEAN*	SEM**	FUNGICIDE	MEAN*	SEM**
AURORA	Check	.33 a	.29	Mertect	.04	.09
	Zyban	.22 ab	.12	Check	0	0
	Chipco	.18 ab	.13	Benlate	0	0
	Difolatan	.08 ab	.10	Chipco	0	0
	Mertect	.06 ab	.08	Daconil	0	0
	Daconil	.02 b	.05	Difolatan	0	0
	Benlate	.02 b	.05	Zyban	0	0
KELLOGG	Captan	2.17	4.13	Difolatan	.23	.46
	Chipco	1.88	2.67	Dacomil	.20	.26
	Check	.42	.67	Check	.14	.28
	Difolatan	.29	.43	Benlate	0	0
	Benlate	.07	.15	Captan	0	0
	Daconil	0	0	Chipco	0	0
MIMA	Benlate	13.62 a	21.06	Zyban	.53	.40
	Mertect	11.62 a	10.84	Check	.22	.09
	Chipco	5.28 ab	3.63	Benlate	.22	.17
	Check	5.15 ab	4.01	Mertect	.16	.06
	Zyban	4.21 ab	5.95	Chipco	.11	.09
	Difolatan	.58 b	1.15	Difolatan	.09	.06
	Daconil	.05 b	.06	Daconil	0	0
TOLEDO	Captan	3.58 a	1.86	Check	1.93 a	.50
	Check	3.63 a	.59	Chipco	.79 b	.29
	Difolatan	2.64 ab	1.01	Captan	.78 bc	.48
	Benlate	1.92 bc	1.60	Benlate	.65 bc	.24
	Daconil	1.86 bc	.92	Difolatan	.46 bc	.12
	Chipco	1.19 c	.58	Daconil	.32 c	.17
TOLEDO -LATE-				Check	3.41 a	1.32
				Benlate	.78 b	.53
				Chipco	.59 b	.31
				Captan	.58 b	.65
				Difolatan	.44 b	.31
				Daconil	.28 b	.15
VIEWCREST	Check	1.37 a	.74	Check	.32	.26
	Chipco	1.18 a	.71	Chipco	.13	.13
	Benlate	1.03 ab	.31	Captan	.12	.12
	Captan	.85 ab	.85	Difolatan	.09	.16
	Difolatan	.35 bc	.35	Daconil	.04	.07
	Daconil	.13 c	.01	Benlate	0	0

*Means (within each nursery and within the same vertical column) followed by the same letter are not significantly different according to Duncan's New Multiple-Range Test, (p .05). Analysis of variance and Duncan's were performed on transformed (arcsin percentage) values for each set of data. However, analyses of variance were not appropriate where one or more treatment mean equaled zero since variances were therefore unequal.

**SEM = Standard Error of Mean.

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